DOI: 10.22055/ivj.2018.105608.1983

Expression analysis of IFN-γ, MX1, MX2, MX3 and HSP70 genes in rainbow trout (*Oncorhynchus mykiss*) administrated with green tea (*Camellia sinensis*)

Sheikhzadeh, N.[1]; Nootash, Sh.[2]; Khani Oushani, A.[3]; Mousavi, Sh.[4] and Tahapour, K.[5]

Received: 12.01.2018 Accepted: 02.10.2018

Abstract

In the present study, the effects of green tea (*Camellia sinensis*) on some antivirus-related gene expressions including IFN-γ, MX1, MX2, MX3 and HSP70 were evaluated in rainbow trout. One hundred and twenty fish (mean weight 23.5 ± 2.5 g) in four groups were fed on diets containing 0, 20, 100 and 500 mg/kg for 35 days. Results showed that green tea at 500 mg kg^{-1} enhanced IFN-γ gene expression in the kidney and liver whereas 20 and 100 mg kg^{-1} green tea upregulated IFN-γ transcription in spleen tissue. All doses of green tea upregulated MX1 transcription in the liver, while MX1 gene expression was upregulated in the spleen of fish received 100 and 500 mg kg^{-1} green tea. MX2 gene expression was upregulated in the kidney of a high dose of green tea and spleen of all doses of green tea. In fish received green tea at 100 and 500 mg/kg, MX3 gene expression in the kidney tissue was upregulated. In fish fed 100 and 500 mg kg^{-1} green tea, upregulation of HSP70 gene in kidney were shown. The present study suggests that green tea, especially at higher doses may effectively modulate the expression of some genes related to antiviral activity in rainbow trout.

Key words: Rainbow trout, Green tea, Virus, Gene expression, Non-specific defence

1- Associate Professor, Department of Food Hygiene and Aquatic Animals, Faculty of Veterinary Medicine, University of Tabriz, Tabriz, Iran
2- Assistant Professor, Department of Food Hygiene and Aquatic Animals, Tabriz Branch, Islamic Azad University, Tabriz, Iran
3- PhD Student of Fisheries, Faculty of Natural Resources and Environment, Science and Research Branch, Islamic Azad University, Tehran, Iran
4- Assistant Professor, Department of Food Hygiene and Aquatic Animals, Faculty of Veterinary Medicine, University of Tabriz, Tabriz, Iran
5- DVM Graduated, Faculty of Veterinary Medicine, University of Tabriz, Tabriz, Iran
Corresponding Author: Sheikhzadeh, N., E-mail: nsheikh@tabrizu.ac.ir

Refrences

Abdel-Tawwab, M.; Ahmad, M.H.; Seden, M.E.A. and Sakr, S.F.M. (2010). Use of green tea, *Camellia sinensis* L., in practical diet for growth and protection of Nile tilapia, *Oreochromis niloticus* (L.), against *Aeromonas hydrophila* infection. The Journal of the World Aquaculture Society, 41: 203-213.

Cabrera, C.; Artacho, R. and Gime´nez, R. (2006). Beneficial effects of green tea—A review. Journal of the American College of Nutrition, 25: 79-99.

Cheng, H.Y.; Lin, C.C. and Lin, T.C. (2002). Antiviral properties of prodelphinidin B-2 3′-O-gallate from green tea leaf. Antiviral Chemistry and Chemotherapy, 13: 223-229.

Cheng, W.; Tsai, R.T. and Chang, C.C. (2012). Dietary sodium alginate administration enhances Mx gene expression of the tiger grouper, *Epinephelus fuscoguttatus* receiving poly I:C. Aquaculture, 324-325: 201-208.

Cho, S.H.; Lee, S.M.; Park, B.H.; Ji, S.C.; Lee, J.; Bae, J. and Oh, S.Y. (2007). Effect of dietary inclusion of various sources of green tea on growth, body composition and blood chemistry of the juvenile olive flounder, *Paralichthys olivaceus*. Fish Physiology and Biochemistry, 33: 49-57.

Crespy, V. and Williamson, G. (2004). A review of the health effects of green tea catechins in in vivo animal models. American Society of Nutrition Science, 3431-3440.

Das, B.K.; Collet, B.; Snow, M. and Ellis, A.E. (2007). Expression of interferon type I and Π, Mx and γIP genes in the kidney of Atlantic salmon, *Salmo salar*, is induced during smolting. Fish and Shellfish Immunology, 23: 514-520.

Ebrahimi, V.; Salati, A.P.; Azarm, H.M. and Hasanpour, S. (2015). Effects of dietary green tea (*Camellia sinensis* L) on acute stress responses in sturgeon hybrid (*Huso huso*♂ × *Acipenser ruthenus* ♀). Aquaculture Research, 1-6. doi:10.1111/are.12908.

El-Beshbishy, H.A. (2005). Hepatoprotective Effect of Green Tea (*Camellia sinensis*) extract against tamoxifen-induced liver injury in rats. Journal of Biochemistry and Molecular Biology, 38: 563-570.

Harikrishnan, R.; Balasundaram, C. and Heo, M.S. (2011). Influence of diet enriched with green tea on innate humoral and cellular immune response of kelp grouper (*Epinephelus bruneus*) to *Vibrio carchariae* infection. Fish and Shellfish Immunology, 30: 972-979.

Huang, L.; Ran, C.; He, S.; Ren, P.; Hu, J.; Zhao, X. and Zhou, Z. (2015). Effects of dietary *Saccharomyces cerevisiae* culture or live cells with *Bacillus amyloliquefaciens* spores on growth performance, gut mucosal morphology, hsp70 gene expression, and disease resistance of juvenile common carp (*Cyprinus carpio*). Aquaculture, 438: 33-38.

Hwang, J.H.; Lee, S.W.; Rha, S.J.; Yoon, H.S.; Park, E.S.; Han, K.H. and Kim, S.J. (2013). Dietary green tea extract improves growth performance, body composition, and stress recovery in the juvenile black rockfish, *Sebastes schlegeli*. Aquaculture International, 21: 525-538.

Lin, Y.R.; Hung, H.C.; Leu, J.H.; Wang, H.C.; Kou, G.H. and Lo, C.F. (2011). The role of aldehyde dehydrogenase and Hsp70 in suppression of white spot syndrome virus replication at high temperature. Journal of Virology, 85(7): 3517-3525.

Lin, S.J.; Tsai, J.H.; Tsai, C.H.; Lin, Y.C.; Hsu, H.T.; Xu, F.L. and Yang, C.C. (2004). The in vivo effects of cytokines modulation for BALB/C mice fed with a traditional combined chinese herb-soaked solution, Yi-Fey Ruenn-Hou tea. Immunopharmacology and Immunotoxicology, 26: 435-444.

Liu, B.; Ge, X.P.; Xie, J.; XU, P.; Cui, Y.T.; Ming, J.H. et al. (2012). Effects of anthraquinone extract from *Rheum officinale* Bail on the physiological responses and HSP70 gene expression of *Megalobrama amblycephala* under *Aeromonas hydrophila* infection. Fish and Shellfish Immunology, 32: 1-7.

Liu, B.; Xu, L.; Ge, X.; Xie, J.; Xu, P.; Zhou, Q. et al. (2013) Effects of mannan oligosaccharide on the physiological responses, HSP70 gene expression and disease resistance of Allogynogenetic crucian carp (*Carassius auratus* gibelio) under *Aeromonas hydrophila* infection. Fish and Shellfish Immunology, 34: 1395-1403.

Meltzer, S.M.; Monk, B.J. and Tewari, K.S. (2009). Green tea catechins for treatment of external genital warts. The American Journal of Obstetrics and Gynecology, 200:233.e1-233.e7

Mir, M.A. and Agrewala, J.N. (2008). Dietary polyphenols in modulation of the immune system. In: Vassallo N, editor. Polyphenols and Health: New and recent advances, Nova, Science Publishers, Pp: 245-72.

Mosca, F.; Romano, N.; Malatesta, D.; Ceccarelli, G.; Brunetti, A.; Bulfon, C. et al. (2013). Heat shock protein 70 kDa (HSP70) increase in sea bass (*Dicentrarchus labrax*, L 1758) thymus after vaccination against *Listonella anguillarum*. Fish Physiology and Biochemistry, 39: 615-616.

Nootash, S.; Sheikhzadeh, N.; Baradaran, B.; Khani Oushani, A.; Maleki Moghadam, M.R.; Nofouzi, K. et al. (2013). Green tea (*Camellia sinensis*) administration induces expression of immune relevant genes and biochemical parameters in rainbow trout (*Oncorhynchus mykiss*). Fish and Shellfish Immunology, 35: 1916-1923.

Ponnuraj, S.; Kanagarajan, M.; Jaganathan, D.; Priya, T. and Deivamarudachalam, D. (2015). Expression analysis of IL-10 and IFN-γ genes in head kidney of *Catla catla* (Ham.) fed with *Limonia acidissima* L. International Journal of Fisheries and Aquatic Studies, 2: 218-223.

Salinas, I.; Lockhart, K.; Bowden, T.J.; Collet, B.; Secombes, C.J. and Ellis, A.E. (2004). An assessment of immunostimulants as Mx inducers in Atlantic salmon (*Salmo salar* L.) parr and the effect of temperature on the kinetics of Mx responses. Fish and Shellfish Immunology, 17: 159-170.

Sheikhzadeh, N.; Nofouzi, K.; Delazar, A. and Khani Oushani, A. (2011). Immunomodulatory effects of green tea (*Camellia sinensis*) on the immune system of rainbow trout (*Oncorhynchus mykiss*). Fish and Shellfish Immunology, 31: 1268-1269.

Tafalla, C.; Chico, V.; Pe´rez, L.; Coll, J.M. and Estepa, A. (2007). In vitro and in vivo differential expression of rainbow trout (*Oncorhynchus mykiss*) Mx isoforms in response to viral haemorrhagic septicaemia virus (VHSV) G gene, poly I:C and VHSV. Fish and Shellfish Immunology, 23: 210-221.

Taylor, P.W.; Hamilton-Miller, J.M.T. and Stapleton, P.D. (2005). Antimicrobial properties of green tea catechins. Food Science and Technology Bulletin, 2: 71-81.

Thawonsuwan, J.; Kiron, V.; Satoh, S.; Panigrahi, A. and Verlhac, V. (2010). Epigallocatechin-3-gallate (EGCG) affects the antioxidant and immune defense of the rainbow trout, *Oncorhynchus mykiss*. Fish Physiology and Biochemistry, 36: 687-697.

Unoshima, M.; Iwasaka, H.; Eto, J.; Takita-Sonoda, Y.; Noguchi, T. and Nishizono, A. (2003). Antiviral effects of geranylgeranylacetone: Enhancement of MxA expression and phosphorylation of PKR during influenza virus infection. Antimicrobial Agents and Chemotherapy, 47(9): 2914-2921.

Wen, Z.S.; Xu, Y.L.; Zou, X.T. and Xu, Z.R. (2011). Chitosan nanoparticles act as an adjuvant to promote both Th1 and Th2 immune responses induced by ovalbumin in mice. Marine Drugs, 9: 1038-1055.

Zhang, C.N.; Tian, H.Y.; Li, X.F.; Zhu, J.; Cai, D.S.; Xu, C. et al. (2014). The effects of fructooligosaccharide on the immune response, antioxidant capability and HSP70 and HSP90 expressions in blunt snout bream (*Megalobrama amblycephala* Yih) under high heat stress. Aquaculture, 433: 458-466.